CONVEYOR DROP GATE DESIGN

It took five successive improvements until the conveyor drop gates worked very well. They must be able to sort packages of various weights up to 7½ pounds at a rate of one per second. A student from the Illinois Institute of Technology describes the sequence of designs.

 Written by Larry Wodnicki for the American Society of Mechanical Engineers Case Contest 1977. The cooperation of Mr. J. P. Massey is gratefully acknowledged.

Computer Drop Gate Design

To aid in the sorting of the various items traveling on conveyors, R. B. Blank Company's shipping area decided to install conveyor drop gates in a section of conveyor. These gates open and close on command from an optical sensor testing each package on the conveyor. Figure 1 shows the operation of a drop gate.

As the drop gate is opened, a part of the conveyor is lowered, allowing packages to be dropped into various bins or carts. By the use of these gates, packages that are traveling on the belts can be sorted into various arrangements.

The drop gate system was designed to the following specifications. The conveyor was to transport 8½"x 11" paper sheets packaged in cellophane bags in weights from a few ounces up to 7½ lbs. The maximum design flow rate was 60 packages per minute. This required that the drop gates open and close in less than one second. A 14" wide belt carries the packages oriented to ±¼" central to the conveyor. A one horsepower motor drives the conveyors at speeds from 75 to 225 fpm.

INITIAL DROP GATE DESIGN

Eight drop gates were needed. In the initial design each consisted of a 1" diameter head shaft fitted with two sets of flange ball bearings and three 6" diameter V-belt sheaves. The tail end consisted of a 3/4" diameter shaft fitted with flange ball bearings and three 6" diameter V-belt sheaves. A fixed gate section was the last section to receive and collect all packages not assigned to the other eight drop gates.

The drop gates were actuated by air cylinders having a bore and stroke of 1½" x 6". A 5/8" diameter rod was used and the air cylinders had a clevis mounting bracket at each end. Air cylinders were chosen

for their speed and low cost. Compressed air was readily available at 85 psi. The gates designed were 30" long, weighed 75 lbs, and had a total swing angle of 46°.

This initial design presented a problem, for although the gate was easily opened by the air cylinder, the closing of the gate was slower than was needed to meet the cycle time of less than 1 second. Although its weight aided in the opening, it hindered the closing of the gate.

Another problem was also encountered. As the maximum opening of the drop gate was reached, the piston of the air cylinder would impact inside the cylinder. The 1½" pneumatic cylinder, which operated the gate, did not have the capability to provide cushioning by exhaust muffling if the cycle time requirement was to be met.

SECOND DESIGN

To help in closing the gates, two sets of counter-balancing weights were placed on the drop gates as shown in Figure 2. This design was intended to put the gate in neutral equilibrium. The design did eliminate the problem of slow lift rate, but it also had a drawback. The impacts between cylinder and piston were now doubled. The shocks occurring during operation of the gate rattled the entire conveyors.

THIRD DESIGN

In the third design the counterbalance weights were replaced by two compression coil springs mounted on the drop gate as pictured in Figure 3. Although the gate opened and closed fast enough for the cycle time, the problems of impacts at the ends of travel were still encountered.

FOURTH DESIGN

In this design, hydraulic shock absorbers were installed to cushion the blow at the ends of travel and allow the drop gate to open and close quickly to maintain cycle time requirements. The set-up chosen is shown in Figure 4.

A swing-mounting arrangement of shock absorber was designed which permitted the shock absorber to cushion both ends of the stroke of the piston. A standard automotive shock absorber was used and it provided a very low cost cushioning means. A wide range of cushioning torque is available by adjustment of position of the pivot location in the swing mounting.

Figure 4 shows the arrangement of the shock absorber, the drop gate, and the pivot locations. The absorber is compressed when the drop gate opens as forced by the pneumatic cylinder. This motion shortens (compresses) the shock absorber and no appreciable force is developed up to $\theta=0°$ because check valves reduce the damping in automotive shocks in the compression stroke direction.

After the drop gate crosses $\theta=0°$, the absorber begins to extend and a force is developed in it which applies a retarding torque to the motion of the drop gate. As the gate swings upward, a retarding torque is supplied only above $\theta=0°$. The retarding torque, in fact, is concentrated in the final portion of the ends of travel. Figure 5 shows the torque vs. swing angle for the drop gate. It is seen that the torque acts principally in the final 30% of the motion and builds up smoothly.

The problems with the drop gate were solved with this design. Not only did the drop gate meet the cycle time of less than one second, but the impacts at the ends of travel were virtually eliminated. The initial

placement of the shock absorber was done by trial and error, but eventually an exact mathematical analysis was completed to determine the optimum positioning.

Although no problems were encountered with the previous design, a new engineer assigned to the project decided that the design could be further improved. If the drop gate were lightened, the compression springs could be eliminated and the cycle time requirement could still be met. The final design therefore, lightened the drop gate, and eliminated the compression springs but still maintained the swinging shock absorbers to cushion the ends of travel.

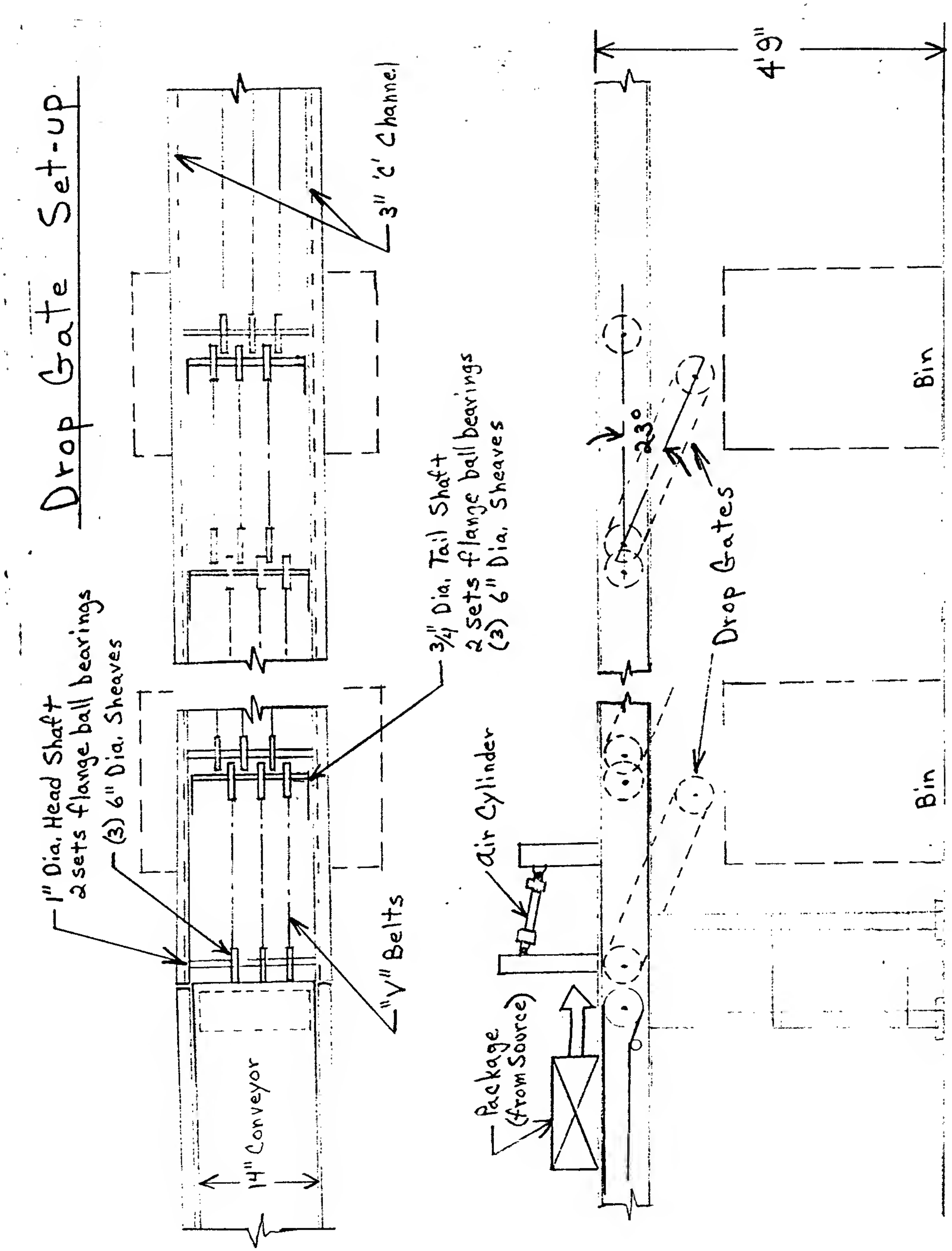


Figure 1

Note: Not to scale. Only one air cylinder shown.

Design No. 2

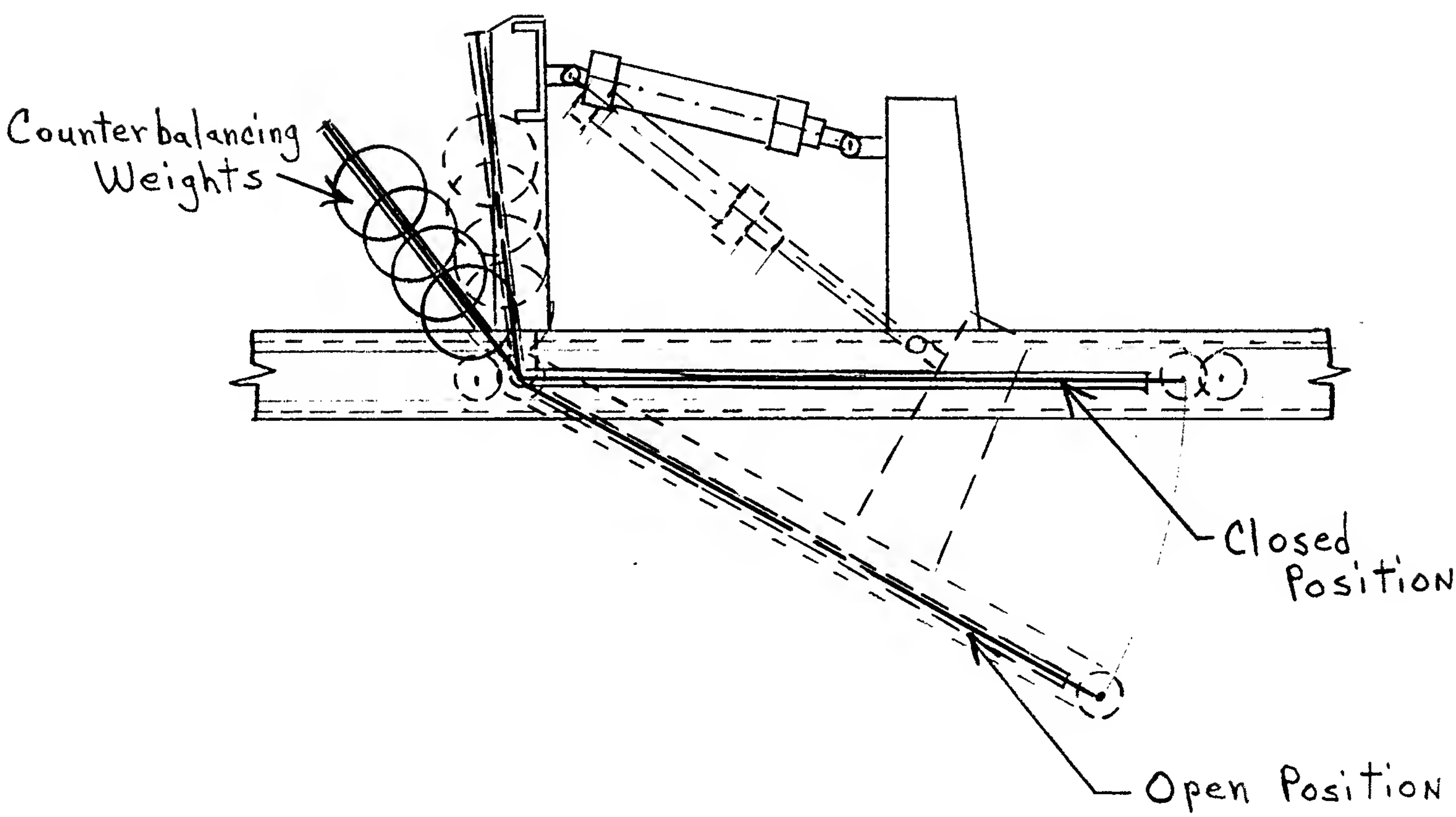


Figure 2

Design No. 3

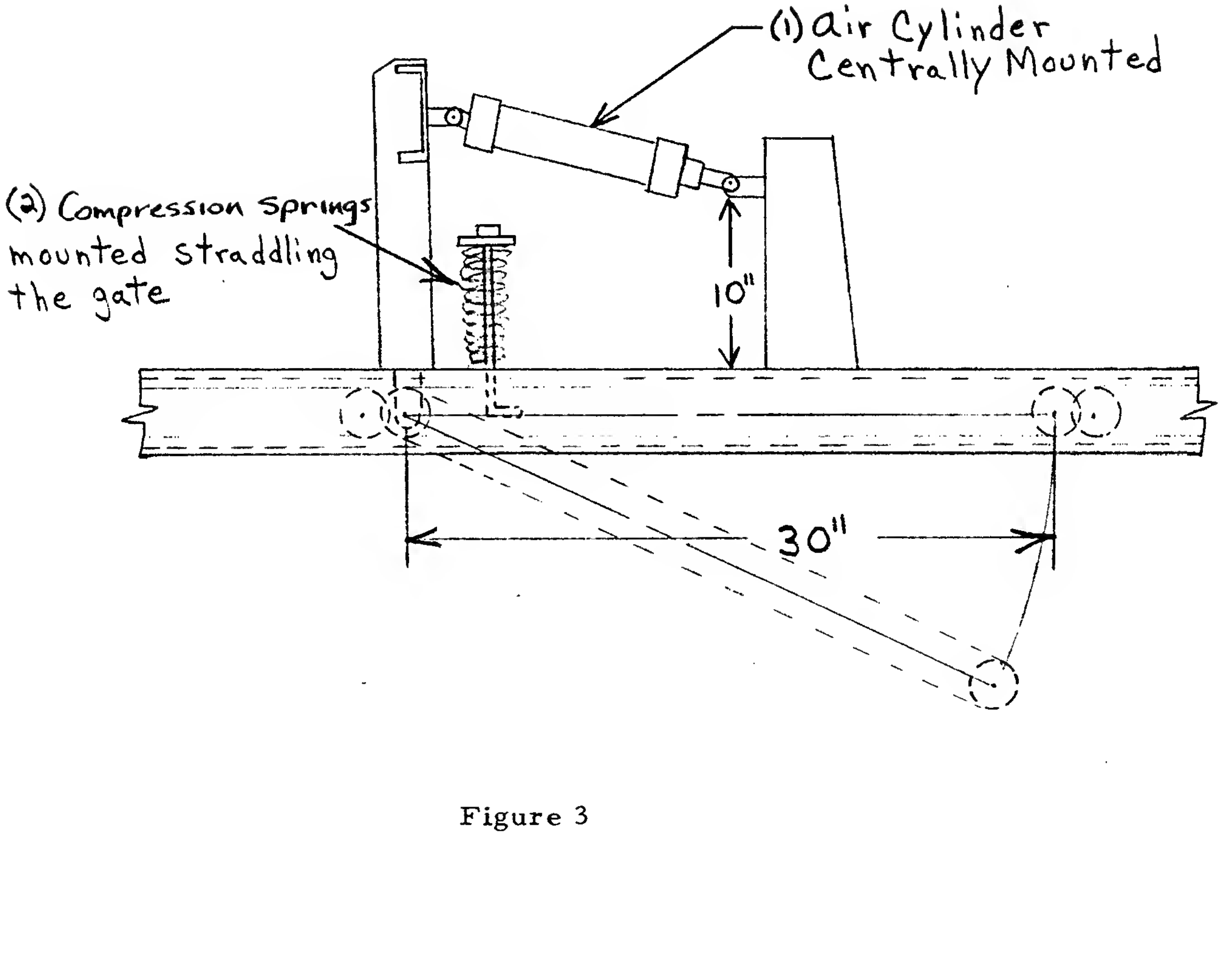


Figure 3

Design No. 4

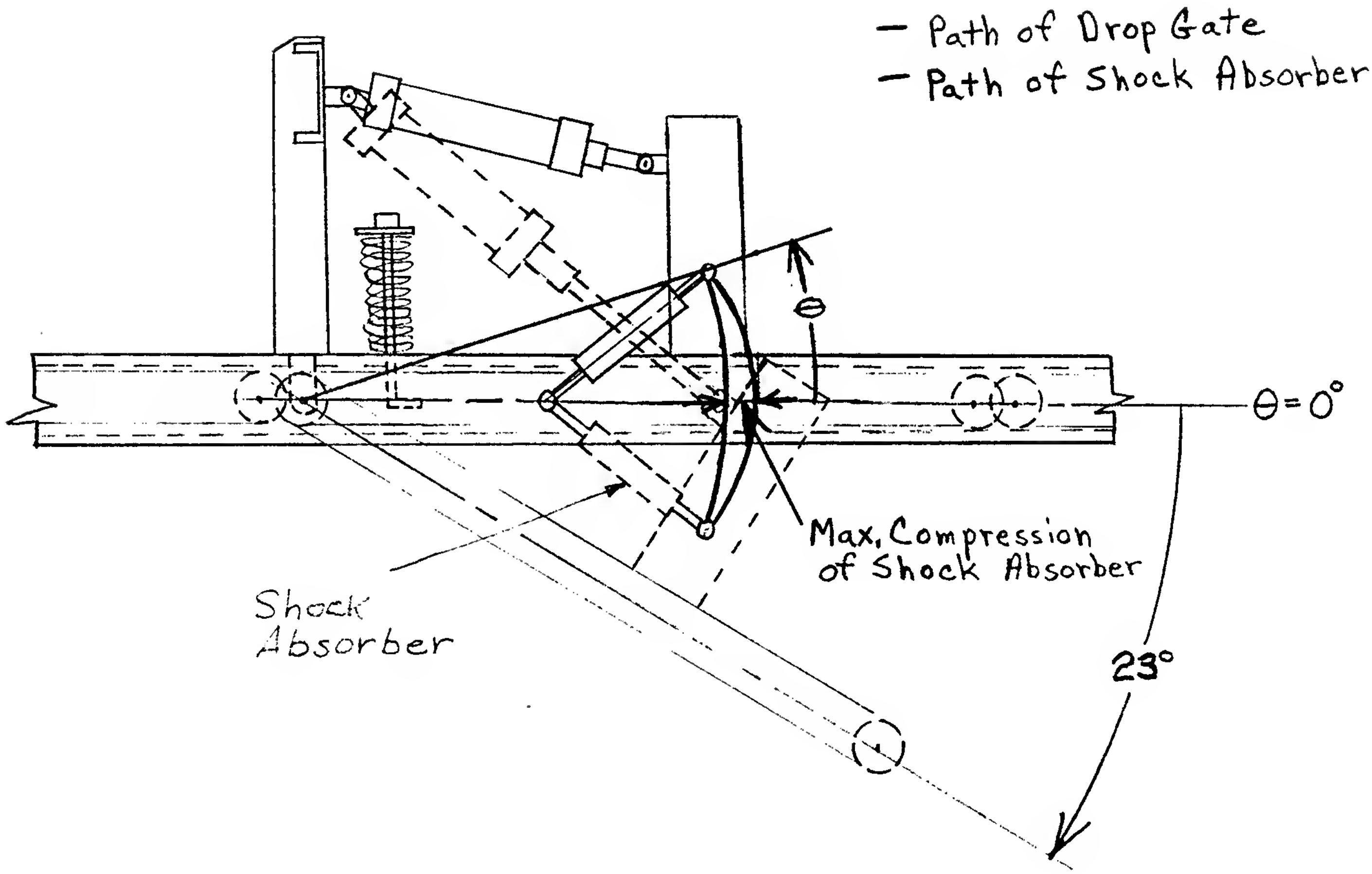


Figure 4

Note: Not to scale

Cushioning Torque vs. Swing Angle

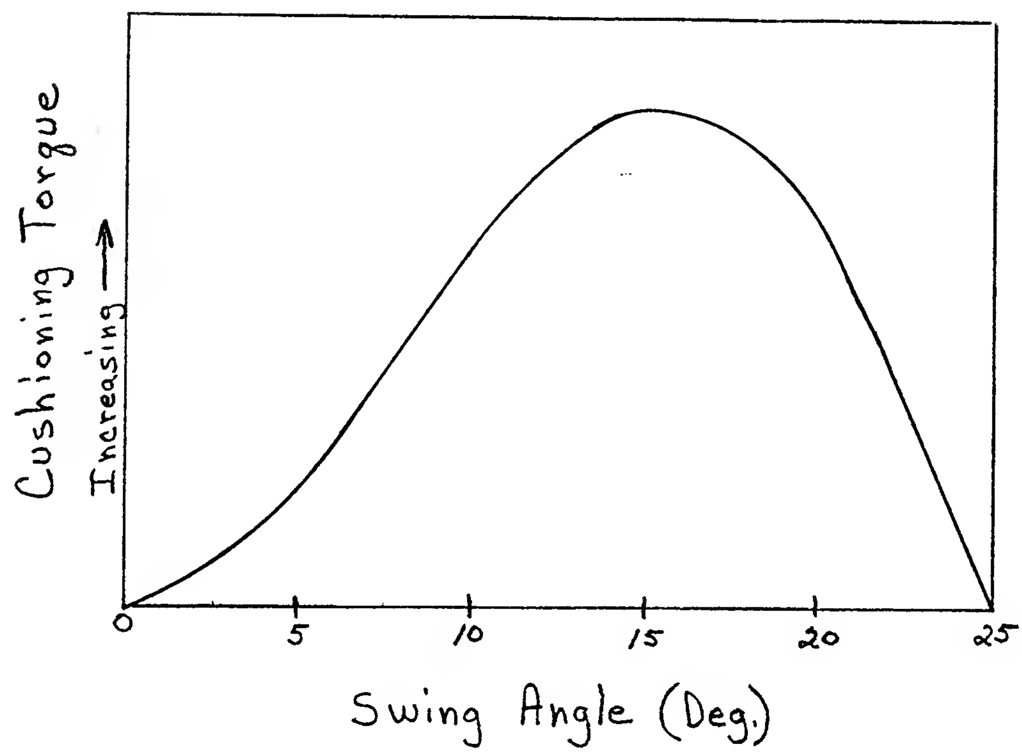
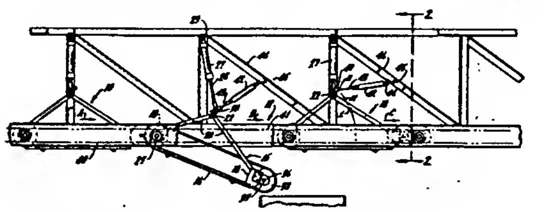


Figure 5

to direct said ink ribbon between said spools in a path which extends past said printing device; the improvement comprising a first means mounting said spools and said ribbon guides to form a single frame unit, and a second means pivoting said frame unit for rotation about an axis perpendicular to said given direction, said second means including means including an electromagnet mounted and arranged to move said frame unit to a printing position by rotation about said axis, with the lengthwise direction of said ribbon extending inclined to said given direction whereby said printing device passes substantially diagonally over said ink ribbon during printing, and in a non-printing position by rotation about said axis whereby the portion of said ink ribbon extending along the recording path of said printing device assumes a position parallel to said given direction.

4,011,935
SORTING MACHINES
John P. Massey, 421 Ruby St., Clarendon Hills, Ill. 60514
Filed Sept. 8, 1975, Ser. No. 611,146
Int. Cl.² B65G ***47/64***
U.S. Cl. 198—365 **6 Claims**



1. A sorting conveyor apparatus for sorting a variety of articles of indefinite configuration comprising a tandem series of sequentially arranged combination conveyordischarge stations, each station comprising:

a station frame mounted for movement in two opposed directions between a conveyor position, in which the frame is aligned with the adjacent stations both fore and aft, to convey articles therebetween, and a discharge position in which one end of the frame is displaced from the adjacent station to discharge an article entering the station;

a conveyor section mounted on the frame and extending longitudinally for substantially the full length of the station frame;

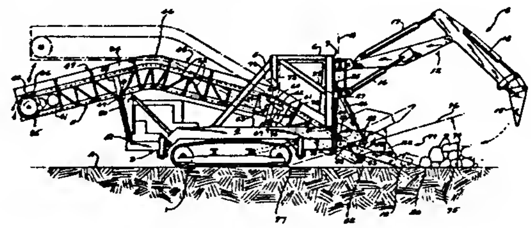
actuator means for moving the frame between its conveyor position and its discharge position;

and shock absorber means being connected at one end to the frame and at the other end to a fixed support, said shock absorber means having an extendible and compressible element constructed to offer substantially no resistance to frame movement during initial movement out of one position and up to a predetermined point whereafter said element retards movement of the frame until the other position is reached, in both directions.

4,011,936
CONVEYOR POSITIONING STRUCTURE FOR LOADING AND CONVEYING MACHINES
Henry C. Hall, Green Bay, Wis., assignor to Northwest Engineering Company, Green Bay, Wis.
Filed Jan. 2, 1976, Ser. No. 646,044
Int. Cl.² B65G ***41/02***
U.S. Cl. 198—517 **16 Claims**

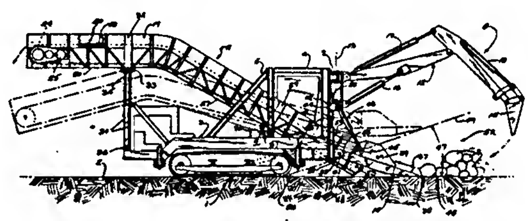
1. In a machine for loading and conveying loose material such as rocks and the like:

a. transport means for supporting and moving said machine on the ground,
b. a machine frame carried by said transport means,
c. material gathering means connected to the front portion of said frame,
d. an elongated conveyor extending from the front to the rear of the machine,
e. an apron disposed at the front of the machine and having a bed extending forwardly from above the front portion of said conveyor for transfer of material from said gathering means to said conveyor,



f. means mounting the rear portion of said apron for pivotal movement about a transverse horizontal axis,
g. means pivotally mounting the front portion of said conveyor to said apron,
h. and means for vertically adjusting said apron so that the said front portion of said conveyor is simultaneously vertically adjusted.

4,011,937
APRON ATTITUDE ADJUSTMENT FOR LOADING AND CONVEYING MACHINES
Sheldon J. Brandtjen, Green Bay, Wis., assignor to Northwest Engineering Company, Green Bay, Wis.
Filed Jan. 2, 1976, Ser. No. 646,011
Int. Cl.² B65G ***41/02***
U.S. Cl. 198—517 **12 Claims**



11. In a machine for loading and conveying loose material such as rocks and the like:

a. transport means for supporting and moving said machine on the ground,
b. a frame carried by said transport means,
c. material gathering means mounted to the front portion of said frame,
d. an elongated inclined conveyor extending from the front to the rear of the machine,
e. an apron disposed at the front of the machine and extending forwardly from adjacent the front portion of said conveyor for transfer of material from said gathering means to said conveyor,
f. means mounting the rear portion of said apron for pivotal movement about a transverse horizontal axis,
g. means for pivoting said apron about said axis for selective engagement or disengagement of the front apron portion with the ground,
h. and means for adjusting said mounting means and said axis vertically.

4,011,938
SUSPENSION IDLER
Arthur F. Kain, 1726 Virginia Court, Lakeland, Fla. 33803
Filed Sept. 8, 1975, Ser. No. 611,312
Int. Cl. B65g ***15/08***
U.S. Cl. 198—824 **13 Claims**

1. A conveyor idler comprising: